Dan Shane, On-Scene Coordinator EPA Region 9

- Environmental Scientist w/30 yrs Experience
- 25 yrs as an EPA OSC
- 3.5 yrs in RCRA Compliance
- 2.0 yrs HW Landfill Inspector for Permitting
- Directed EPA Response to 3 Major Tire Fires – Panoche TF, Westley TF, Ordot Landfill TF
- Expert Testimony that Closed Large Tire Dump

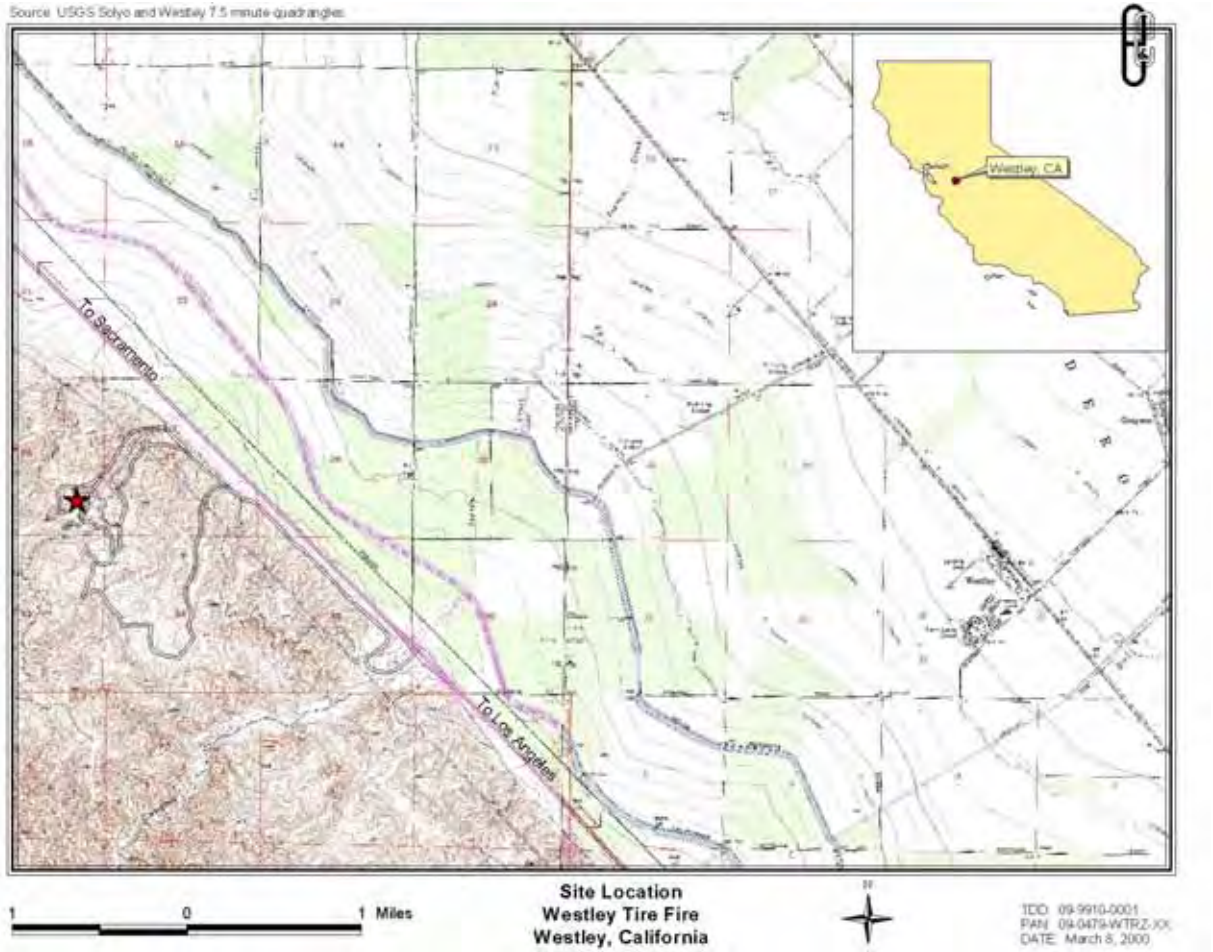
Case Study Objectives

- Overview and Background
- Regulatory Authorities
- Health & Environmental Assessment/Impacts
- Suppression Techniques & Tactics
- Safety and Communication Issues
- Waste Management issues
- Lessons Learned

Westley Tire Fire Case Study

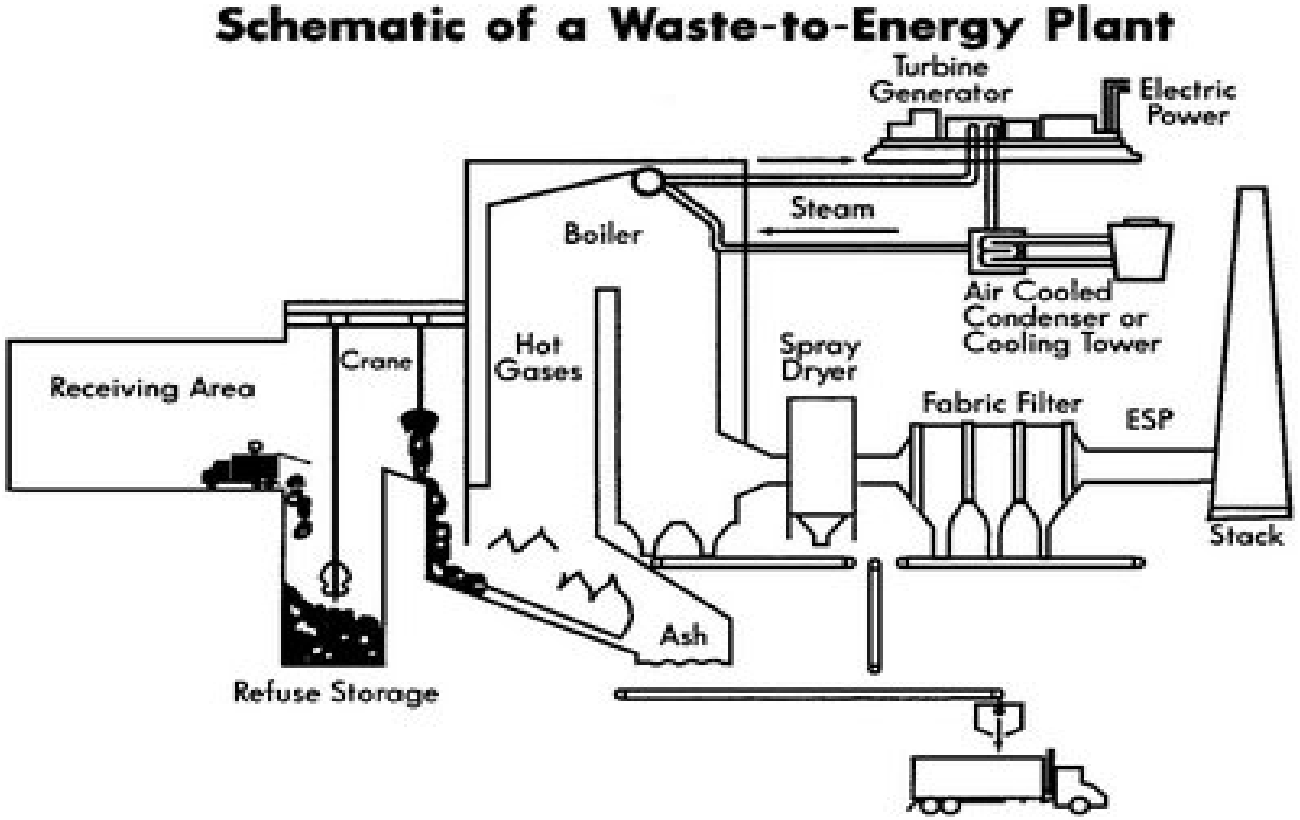
- Located near Modesto ¼ mile from I-5
- Rural farming community, Volunteer FD
- Est. 42 million tires dumped on steep slopes of canyon in 1987
- Tire burning plant start-up in 1988
- Tire pile reduced to 7 million tires
- Suspected arson = convenient way of dodging regulatory enforcement action
- Est. 5 million tires engulfed in fire

Site Location



Modesto Energy Limited Partnership

MELP Electrical Generation Plant



Aerial View of Tire Dump Before Fire

What if?

Some persons waste is another persons Pot of Gold

Towering Inferno

Vapor Ignition

Situation

- Enormous piles up to 80 feet high on steep slopes
- Insufficient pile separation, fire breaks and no firefighting equipment on site
- No water supply
- Rare lighting strike vs arson story
- Temps over 2,000° F
- Smoke plume rose to 6,000 feet and impacted San Joaquin Valley
- Ash fallout 60 miles away
- Pyrolytic oil produced and ignited
- Grassland fire erupted charring 1,500 acres

Adequate Pile Separation?

Pyrolytic Oil Flowing from Tire Pile

Oil Flowing to Cattle Watering Pond

Raging Tire and Oil Fires

Removing Pyrolytic Oil with Vacuum Truck

Situation, Con't

- Black rain fell on SF Bay area
- Serious community concerns about health effects from inhalation of smoke
- Difficult to organize an ICS structure
- Air monitoring off-site by CARB and on-site by EPA
- Schools closed and farmers dumped produce on side of roadways

Regulatory Authority

- OPA used to remove pyrolytic oil
  - Control oil flow using fire suppression
  - Contain oil and manage water runoff
  - Remove oil to 20,000 gal Baker Tanks
  - Dispose or recycle water and pyrolytic oil
- CERCLA used for air monitoring
- Story about NPFC OSLTF and funding

POTENTIAL THREATS

- Toxic Air Contaminants
  - Benzene, 1-3 Butadiene, CO and PM-10
- Pyrolytic Oil Runoff into creek
  - California aqueduct downstream
- Contamination of soil and groundwater
- Arcing of PG&E Power Transmission Tower Lines
- Natural Gas High Pressure Pipeline

Health & Environmental Assessment and Impacts

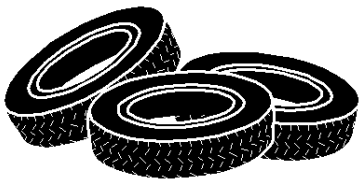
- Smoke and Vapor Inhalation Hazards
- Story about SCBAs vs APRs
- Air Monitoring and Modeling
- Ash, Debris and Soil Contamination
- Groundwater Impacts
- Pyrolytic Oil Chemical Breakdown
- Recycling vs Waste Disposal

Chemical Composition of Tires

Typical types of materials used to manufacture tires:

Synthetic Rubber
Natural Rubber
Sulfur and sulfur compounds
Silica
Phenolic resin
Oil: aromatic, naphthenic, paraffinic
Fabric: Polyester, Nylon, Etc.
Petroleum waxes
Pigments: zinc oxide, titanium dioxide, etc.
Carbon black
Fatty acids
Inert materials
Steel Wire

Source: U.S. Rubber Manufacturers Association / Scrap Tire Management Council



Tire Fire Dynamics

- IGNITION/PROPAGATION PHASE
  - Open flames, flammable vapors
- COMPRESSION STAGE
  - Tires loose rigidity, collapse in on themselves, heat and smoke increase
- PYPROLYSIS/SMOLDERING STAGE
  - Deep seated fire, low open flames, ash/wire/steel forms a crust layer over the piles
- SUPPRESSION = slows down combustion process = more pyrolytic oil generated but less smoke = more VOCs to breath

Pyrolytic Oil

- Pyrolysis = Thermochemical decomposition of organic matter at elevated temperatures (above 800 ? F) in the absence of oxygen.
- Average passenger tire contains 2 gals oil
- 5 million tires = 10 million gallons
- Exxon Valdez Spill = 11 million gallons
- Recovered 250,950 gallons of pyrolytic oil during the Westley Tire Fire

Pyrolytic Oil, Con't

- Pyrolytic Oil is known to contain the following contaminants:
- Napthalene and Anthracene
- Benzene and Ethyl Benzene
- Toluene
- Thiazoles
- Amines
- Various Metals (Cd, As, Ni, and Zn)

Comparison of Pyrolytic Oil and Used Crankcase Oil

PYROLYTIC OIL		USED OIL
Benzene	880 ppm	20 ppm
Toluene	2600 ppm	380 ppm
Xylene	2100 ppm	550 ppm
Napthalene	710 ppm	330 ppm
Lead	3.4 ppm	240 ppm
Zinc	830 ppm	480 ppm
Fash Point	120° F‘	> 140 F

Recycling Pyrolytic Oil

- VOCs higher but comparable to used oil
- Heating value was 17,000 BYU's per pound (between coal and #6 fuel oil)
- Metal concentrations below reg. levels
- Local refinery tested & accepted oils
- CA DTSC made a HW determination based on a 96-hour fish bioassay test
- Local refinery did not have HW permit

Recycling Oil, Con't

- Cal-EPA would not grant a one-time emergency permit to use as fuel oil
- Situation became critical due to lack of storage capacity
- Oil sent to oil recycler and Cal-EPA began enforcement action
- Oil was shipped to Fedonia, Ks to the Systech Cement Kiln as fuel
- Cost was $250,000 and unnecessary

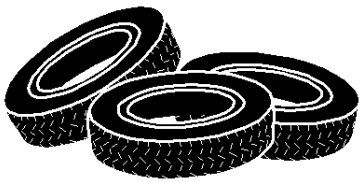
Chemical Composition of Tire Ash

Contents	Weight by Percentage	
Zinc		51.48%
Lead		0.22%
Iron		6.33%
Chromium		0.03%
Copper		0.55%
Nickel		0.03%
Arsenic		0.02%
Aluminum		0.76%
Magnesium		0.50%
Sodium		0.01%
Potassium		0.01%
Magesium Dioxide		0.36%
Tin		0.03%
Silicon		6.85%
Cadmium		0.05%
Carbon		32.20%
	Total	99.43%

Note: These results are from incineration of 100% tire fuel.

Sources: Radian Corporation, Results From Sampling and Analysis of Wastes From the Gummi Mayer Tire Incinerator, May 1985.

Source: U.S. Rubber Manufacturers Association / Scrap Tire Management Council



Ash and Contaminated Soils

- Ash is known to contain: Heavy metals (Pb, As, and Zn) and hydrocarbons
- Low concentrations of volatile and semi-volatile compounds
- Low concentrations of metals with the exception of zinc (11,000 mg/kg)
- Ash residue contained high concentrations of TRPH (36,000 mg/kg)

Ash and Debris Piles

Loading Contaminated Ash

Fire Suppression Water

- Highest concentrations of VOCs were acetone (9.8 mg/l), butanone (1.8 mg/l) and benzene (1 mg/l)
- Highest concentrations of semi-volatiles were benzoic acid (380 mg/l), phenol (19 mg/l), and 2-methylphenol (6.9)
- Highest concentrations of metals was zinc (55 mg/l)
-

Fire Suppression Water, Con't

- pH was 6.8
- TRPH was 20 mg/l
- Significant reduction of contaminants after continuous recycling of water
- Analysis showed water did not exhibit hazardous waste characteristics
- Approx 1.2 million gals waste water was disposed of by deep will injection

Groundwater Impacts

- The primary COC for groundwater was benzene
- The Regional Quality Control Board required Modesto Energy Limited Partnership (MELP) to install groundwater monitoring wells in the ravine below the final cattle watering pond

Impacts on Air Quality

Air Emissions

- The following are the estimates of the total quantities of three chemicals emitted from a fire involving 5 million tires:
- 141,000 lbs of Benzene
- 70,000 lbs of Polycyclic Aromatic Hydrocarbons (PAHs)
- 10,000 lbs of Butadiene
- All 3 chemicals are know carcinogens

Air Emissions, Con't

- Tire fire smoke and vapors are known to contain the following chemical compounds:
- VOCs and SVOCs
- Particulate metals, heavy metals
- Carbon monoxide
- Dioxins and Furans
- S0x and N0x and PCBs
- Acid Gases (HCL, H_2S)

AIR EMISSIONS, Con't

- Sulfur Dioxide
  - Acid Rain
- Polycyclic Aromatic Hydrocarbons
  - By-products of combustion
  - 100 different chemicals
  - Cause cancer in humans and animals and humans
  - Wide variety of health problems
- Dioxin and Furans

AIR EMISSIONS, CON'T

- Particulate Matter (PM-10)
  - Increased respiratory problems
  - Aggravates asthma
- VOCs
  - Damage to liver, kidney & central nervous system
  - Some cause cancer
- NOx
  - Highly reactive gases that can cause ground level ozone, acid rain, water quality impacts, formation of other toxic

Air Monitoring and Surveillance

- Off-site air monitoring was conducted by CA Air Resources Board
- EPA performed source and on-site air monitoring and sampling
- Smoke in the fire plume had 570 ppb butadiene and 930 ppb benzene
- 55 % by volume had 3 compounds in oil headspace analysis (isobutylene, benzene and toluene)

Air Monitoring, Con't

- Free burning tires incinerated VOCs
- Suppression = More VOCs to breath
- Personal air sampling for PAHs, VOCs and metals
- Downwind monitoring found some concentration spikes for particulates
- NARAC at LLNL performed plume modeling, predicted smoke deposition

Higher VOC emissions

Continuous Emissions Monitors

- Only generally used for sulfur oxides (SOx), nitrogen oxides (NOx), oxygen (O2) and carbon monoxide (CO)
- Technology now exists to continuously monitor:

Ammonia (NH4)

Carbon Dioxide (CO2)

Hydrogen Sulfide (H2S)

Acid Gases:
- Sulfuric Acid (H2SO4)
- Hydrofluoric Acid (HF)
- Hydrochloric Acid (HCl)

Products of Incomplete Combustion (PICs):
- Dioxins & Furans
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Volatile Organic Compounds (VOCs)

Metals:
- Antimony (Sb)
- Arsenic (As)
- Barium (Ba)
- Cadmium (Cd)
- Chromium (Cr)
- Lead (Pb)
- Manganese (Mn)
- Mercury (Hg)
- Silver (Ag)
- Nickel (Ni)
- Zinc (Zn)
- …and more

Suppression Techniques & Tactics

Hopeless Fire Suppression Tactic

Suppression Tactics, Con't

- USCG recommended Williams Fire and Hazard Control, Mauriceville, Texas
- Brought in largest heavy equipment – Komatsu excavators, crawler dozers and large wheeled loaders
- Highly proficient logistics system for procuring large numbers and types of heavy equipment, foam supplies, mounted foam monitors

Komatsu Excavator in Fire

Fire Suppression Tactics, Con't

- Initial strategy – extinguish oil fire, prevent re-ignition of oil, reduce smoke emissions
- Williams used a Daspit Tool capable of delivering up to 500 gpm water/foam solution
- Foam was 3M Light Water AFFF/ATC proportioned at 3% to attack hydrocarbon fire
- Form a foam blanket, control vapor emissions
- Smoldering debris spread out and doused

Fire Suppression Tactics, Con't

- We had extremely lucky break
  - Williams used excavator to do exploratory digging along outer fringe of main burning tire pile
  - We discovered only the upper 10 feet of the pile was actually engulfed in fire
  - Steep slope allowed oil to flow away from the fire resulting in slower burning pile (robbed of fuel)
  - Armed with this information a tire fire-fighting strategy was developed to separate & extinguish

Fire Suppression Tactics, Con't

- Ridge and Ravine Teams were outfitted with 2,000 gpm foam monitor canons and giant excavators and tracked dozers
- A new foam, 3M SFFF, was used to penetrate and extinguish the deep seated fires
- The foam had ability to greatly reduce surface tension of water and allowed solution to penetrate quickly to seat of fire for effective extinguishment

Fire Suppression Tactics, Con't

- Ridge team used large volume, high pressure monitors to "hydro-mine" burning tires and wash them down slope to the excavators
- The 113 ton, 56' reach Komatsu 1100 "Big Girl" excavator literally moved mountains of tires to the bottom of the hill
- The still very hot tires had to be thoroughly quenched in slurry pits dug into the streambed
- The cooled tires were loaded onto giant loaders and hauled to the stockpile

Komatsu Excavator

LESSONS LEARNED

- Fighting large tire fires is very difficult and dangerous
- A large tire fire is a unique multi-category incident – It combines elements of a major fire, hazardous materials release and an oil spill discharge all rolled up into one event
- Using a specialist such as WFHC with major experience in fighting large oil fires was a key to the success of the operation. This prevented fatalities and injuries

Lessons Learned, Con't

- Fire Departments may only be equipped with SCBA's. They need to have APRs for long term fire fighting activities
- The use of portable high volume, high pressure foam monitors working in tandem with large excavators and dozers to overhaul burning tire debris is most effective, but costly
- The Komatsu 1100 "Big Girl" literally moved mountains of tires to the bottom of the hill

Fire-Fighters & EO's Working in Tandem

Lessons Learned, Con't

- Thoroughly quench burning tires – the wire inside may still be hot enough to re-ignite
- Plan early on a strategy for recycling fire-fighting water to extinguish the fire
- Reuse of water may reduce contaminant levels to below hazardous waste levels
- A large on-site repair maintenance facility working around the clock may be needed to fix or replace equipment damaged by heat, falling tires and wires that coil around the axles

A Real Pain In-The-Ass

Overhauling Burning Tires

Lessons Learned, Con't

- Take care of local volunteer firefighters
  - Hire them to keep a night watch over fire
  - Train them to operate monitors when needed to protect extinguished areas from radiant heat of main fire
- Be prepared for pyrolytic oil runoff and soil saturation
  - Approx. 80% of oil generated by fire occurred in the first 10 days

48” Runoff Diversion Pipeline

Lessons Learned, Con't

- Use of a 30 foot section of 10 inch steel pipe to convey pyrolytic oil to the containment pond was effective in snuffing out the flames
- A new foam product from 3M Company, SFFF (Class A Foam), proportioned at 1% was notably superior to other products
- Foams are used for specific purposes (i.e., vapor blanket, flame knockdown, structural penetration)
- The logistics of sustaining a continuous supply of foam was a monumental task

Lessons Learned, End

- Large quantities of foam may be needed
  - 38,000 gals foam used at a cost of $607,000
- Begin researching recycling options early in the response. Bring in the State regulators.
- Use a Unified Command and bring in the outlier organizations
- Critical staff must disengage from normal duties and be present on daily basis to expedite issues important to the UC
- Resist public or government pressure to demonstrate vendor products. All products should already be pre-qualified.

Site Remediation

Post-Remediation

Post Remediation

Summary of Costs, Labor and Equipment

- EPA costs = $3.7 million
- State costs = $827,000
- MELP costs = $1.0 million
- Site Remediation and Restoration = $20 million
- Total cost ~ $25 million (ER + Remediation)
- Total personnel = 54 (1-EPA, 5 USCG, 4-START, 24-ERRS, 14-WFHC, 6-VFD)
- Equipment = 7-excavators, 8-dozers, 3-loaders, 2-dump trucks, 2-compactors, and much more

Additional Statistics

- WHFC arrived on-scene on 9/30/99 and fire was officially declared extinguished on 10/27/99. Fire extinguished in 27 days.
- 38,000 gallons of foam needed to extinguish the fire costing $607,000.
- 250,950 gallons of pyrolytic oil recovered. Approx 80% of oil recovered in first 10 days

Questions?